411951-192

RFID TAG WITH EMBEDDED INTERNET ADDRESS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to automated data collection systems that collect information from radio frequency identification (RFID) transponders, and more particularly, to an automated data collection system that uses an imbedded Internet address to facilitate communication of information regarding the RFID tag to a location on the Internet.

2. Description of Related Art

In the automatic data identification industry, the use of RFID transponders (also known as RFID tags) has grown in prominence as a way to track data regarding an object to which the RFID transponder is affixed. An RFID transponder generally includes a semiconductor memory in which digital information may be stored, such as an electrically erasable, programmable read-only memory (EEPROMs) or similar electronic memory device. Under a technique referred to as "backscatter modulation," the RFID transponders transmit stored data by reflecting varying amounts of an electromagnetic field provided by an RFID interrogator by modulating their antenna matching impedances. The RFID transponders can therefore operate independently of the frequency of the energizing field, and as a result, the interrogator may operate at multiple frequencies so as to avoid radio frequency (RF) interference, such as utilizing frequency hopping spread spectrum modulation techniques. The RFID transponders may either extract their power from the electromagnetic field provided by the interrogator, or include their own power source.

Since RFID transponders do not include a radio transceiver, they can be manufactured in very small, lightweight and inexpensive units. RFID transponders that extract their power from the interrogating field are particularly cost effective since they

lack a power source. In view of these advantages, RFID transponders can be used in many types of applications in which it is desirable to track information regarding an object. One such application is to include RFID transponders in labels affixed to manufactured goods, packages or other such objects. The RFID transponders would contain stored data regarding the objects, such as the customer information, product specifications, serial numbers, shipping requirements, etc. A handheld or fixed position RFID interrogator can interrogate the RFID transponder in order to recover the stored data. The RFID interrogator may then communicate the collected data to a computer or computer network for further processing by a particular software application.

Despite the advantages of RFID transponders, there is an inherent limitation in the amount of information that can be stored in the memory of an RFID transponder. At the same time, there is an almost limitless capacity for storage of data files and applications on a network. Such networks may include a local area network (LAN), a wireless local area network (WLAN) or a wide area network (WAN), or may further comprise the Internet or a corporate intranet. As known in the art, the Internet is made up of more than 100,000 interconnected computer networks spread across over one hundred countries, including commercial, academic and governmental networks. Businesses and other entities have adopted the Internet as a model for their internal networks, or so-called "intranets." Discrete locations within servers connected to the network are identified using an address. One portion of the Internet known as the World Wide Web includes graphical information stored and accessed in the form of so-called web pages, with each such web page having a unique address referred to as a Uniform Resource Locator (URL). Another portion of the Internet is used to communicate electronic mail (or e-mail) messages, with individual users being assigned unique e-mail addresses. There presently exists no efficient way to link information regarding an RFID transponder to a corresponding location on the Internet, such as to supplement the limited storage capacity of the RFID transponder with the enormous storage capability of a network.

Another drawback of conventional automated data collection systems is that the conveyance of information from the RFID interrogator to the software application operating on a computer or computer network is independent of the information content. The interrogator generally forwards the collected information to a software application irrespective of the content of the information, and the software application then determines what actions to take with respect to the information. There presently exist many known RFID transponder types having unique data formats and protocols, with each such format and protocol being generally incompatible with each other. More than one type of RFID transponder may be present within the operating environment of a single RFID interrogator, such as a first type of RFID transponder disposed on a truck and a second type of RFID transponder disposed on a pallet carried by the truck. Thus, separate software applications may be used to process the information from each of the RFID transponder types, and yet another software application may be used to distinguish between the collected information and route the information to the appropriate software application for subsequent processing. The use of a software application to provide the routing function necessarily limits the flexibility of the network applications that use the collected information.

It would therefore be desirable to provide an automated data collection system in which the RFID transponder can identify or communicate with a particular location on a network by designating its associated address. It would be further desirable to include information or applications relating to an RFID transponder on the network at the location designated by the address embedded in the RFID transponder.

SUMMARY OF THE INVENTION

The present invention is directed to an RFID transponder comprising a memory space having a predetermined data field for storing a destination address identifying a location on a network, such as the Internet. The destination address may further comprises a Uniform Resource Locator (URL) defining the location of a web site associated with the RFID transponder, or an e-mail address for an entity associated with the RFID transponder.

In an embodiment of the invention, a computer network comprises a client computer having a browser application executing thereon, an RFID tag having a memory containing a network address corresponding to the RFID tag, and an RFID reader connected to the client computer and being adapted to communicate with the RFID tag. The RFID reader provides the network address recovered from the RFID tag to the client computer. The client computer thereby communicates with the location on the network corresponding to the RFID tag using an application, such as a web browser or e-mail client. A host server is connected to the client computer, and may be further connected to the Internet. The client computer thereby can access the location on the network by operation of the application through the host server to communicate information or execute applications.

In another embodiment of the invention, a method for reading an RFID tag comprises interrogating the RFID tag, receiving information stored in memory of the RFID tag including a network address identifying a location on a network corresponding to the RFID tag, and communicating with the location identified by the network address. The destination address may further comprise a Uniform Resource Locator or e-mail address. The method further comprises executing an application associated with the location, such as a Internet browser, e-mail client, Java-applet.

A more complete understanding of the RFID tag having an embedded Internet address will be afforded to those skilled in the art, as well as a realization of additional advantages and objects thereof, by a consideration of the following detailed description of the preferred embodiment. Reference will be made to the appended sheets of drawings which will first be described briefly.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram illustrating a computer network having RFID readers arranged to read data from RFID transponders;

Fig. 2 is a block diagram of an exemplary RFID transponder; and

Fig. 3 is a flow chart illustrating operation of an RFID reader.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The present invention satisfies the need for an automated data collection system in which the RFID transponder has an embedded address to facilitate communication with a location on a network such as the Internet. In the detailed description that follows, like element numerals are used to describe like elements illustrated in one or more of the figures.

Referring first to Fig.1, an automated data collection environment is illustrated that includes a computer system forming part of a local area network (LAN) or wide area network (WAN). The computer system includes a host server computer 14 attached to a network 12, and has plural client computers such as personal computer (PC) 16 connected to the host server computer through the network. As known in the art, the computers attached to the network 12 may communicate using various protocols, such as Ethernet. The host server computer 14 may comprise a high-speed microcomputer, minicomputer or mainframe computer that acts as a conduit for communication of data packets between the client computer 16 and the outside world. It should be appreciated that a large number of client computers may be coupled to the server computer 14 through the network 12. The host server computer 14 may also provide various system applications for the client computers, such as e-mail, file management, database, word processing, etc. The exemplary client computer 16 typically comprises a processor and non-volatile data storage device, such as a hard disk drive, optical disk drive, and the like. As used herein, the term "processor" is intended to broadly encompass microprocessors, digital signal processors (DSPs), application specific integrated circuits (ASICs), field programmable gate arrays (FPGAs), and the like. A user can enter commands and information into the client computer 16 through input devices such as a keyboard, mouse, microphone, joystick, game pad, scanner, etc. A video monitor or other visual display device coupled to the client computer 16 provides visual output to the user. Other output devices coupled to the client computer 16 may include printers, speakers, scanners, external data storage, etc.

The host server computer 14 may also be coupled to the Internet 42. As shown in Fig. 1, a remote server 44 is also coupled to the Internet. The remote server 44 may also have client computers (not shown) connected thereto, thereby permitting the routing of messages between end users connected to the respective client computers. The remote server 44 may also provide other applications, such as hosting a web site. The client computer 16 may include a browser application that enables the user to view graphical information communicated across the computer network, including web pages that are stored on the remote server 44, such as Netscape Navigator® from Netscape Communications Corp. or Internet Explorer® from Microsoft Corp. The client computer 16 may also include an e-mail client, such as Outlook® from Microsoft Corp.

The client computer 16 is further connected to an RFID reader 18 adapted to read encoded data stored in RFID tags, such as RFID tag 30a. The RFID reader 18 may have a hard-wired link to the client computer 16, or alternatively, may communicate over an RF or optical data link to the client computer or the network 12. Also, the RFID reader 18 may be mounted in a fixed location with respect to moving RFID tags, such as above a conveyor belt, or alternatively, the RFID reader may be manipulated by a user by hand into proximity with the RFID tags. As known in the art, the RFID reader 18 communicates with the RFID tag 30a using RF signals. An example of an RFID reader is provided by U.S. patent application Serial Number 09/153,617, filed September 15, 1998, entitled "Radio Frequency Identification Interrogator Signal Processing System For Reading Moving Transponders," the subject matter of which is incorporated by reference herein in its entirety.

The host server computer 14 may further communicate with plural wireless devices, such as the handheld scanning terminal 24, through an RF access point 22. The RF access point 22 is connected directly to the network 12, and extends the range of the network to include a wireless local area network (WLAN). The handheld scanning terminal 24 may be adapted to perform computing and communicating functions, and comprises a processor, non-volatile data storage device (e.g., hard disk drive or flash memory), an input device (e.g., keyboard or touchpad) and a display (e.g.,

liquid crystal display (LCD)), as in the client computer 16. The handheld scanning terminal 24 may be adapted to execute many of the software applications that would ordinarily operate on a full-size personal computer, including a web browser application. In a preferred embodiment of the present invention, the scanning terminal 24 further includes an integrated RFID reader similar to the RFID reader 18 described above. The integrated RFID reader permits the scanning terminal 24 to thereby read encoded data stored in RFID tags, such as RFID tag 30b. The handheld scanning terminal 24 processes the data read from the RFID tag 30b, and communicates the data to and from the network 12 as necessary. It should be appreciated that the handheld scanning terminal 24 may also be provided with an optical scanning capability, such as to read optical indicia including one and two-dimensional bar code symbols.

Referring now to Fig. 2, an exemplary RFID tag 30 is illustrated in greater detail. The RFID tag 30 corresponds to the RFID tags 30a-30b described above with respect to Fig. 1. More particularly, the RFID tag 30 includes an RF interface 34, control logic 36 and memory 38. The RF interface 34 is coupled to an antenna 32, and may include an RF receiver that recovers analog signals that are transmitted by an RFID reader, and an RF transmitter that sends data signals back to the RFID reader. The RF transmitter may further comprise a modulator adapted to backscatter modulate the impedance match with the antenna 32 in order to transmit data signals by reflecting a continuous wave (CW) signal provided by the RFID reader. The control logic 36 controls the functions of the RFID tag 30 in response to commands provided by the RFID reader that are embedded in the recovered RF signals. The control logic 36 accesses the memory 38 to read and/or write data therefrom. The control logic 36 also converts analog data signals recovered by the RF interface 34 into digital signals comprising the received commands, and converts digital data retrieved from the memory 38 into analog signals that are backscatter modulated by the RF interface 34. The RFID tag 30 may be adapted to derive electrical power from the interrogating signal provided by the RFID reader, or may include an internal power source (e.g., battery).

The memory 38 of the RFID tag 30 contains a space for data storage having plural fields that may be defined by an end user of the automated data collection system. In the present invention, at least one of the fields is predefined to include an address field. The address field defines a specific location on the Internet. For example, the address may comprise a Uniform Resource Locator (URL) used to identify a website hosted on a server connected to the Internet, such as the host server 14 or the remote server 44, that contains information or applications associated with the particular RFID tag 30. It should be appreciated that a URL embedded in an RFID tag may identify a location of a file that may exist anywhere within a single computer (such as including client computer 16), a wireless local area network (such as including scanning terminal 24), a local area or wide area network (such as including network 12 and host server 14), the Internet 42, or all other networks connected thereto.

As known in the art, a URL contains the protocol prefix, port number, domain name, subdirectory names and file name. Port addresses are generally defaults and are rarely specified. To access a home page on a web site, only the protocol and domain name are required. For example, the URL http://www.intermec.com retrieves the home page for the Intermec Technologies Corporation. The http:// part of the URL is the web protocol, and www.intermec.com is the domain name. If the page is stored in another directory, or if a page other than the home page is required, slashes are used to separate the names. For example, the URL http://www.intermec.com/products/rfid.htm points to the page describing Intermec's RFID products. There are other Internet protocols defined by URLs, including: (a) http:// which refers to a World Wide Web server; (b) ftp:// which refers to a File Transfer Protocol server; (c) news:// which refers to a Usenet newsgroup server; (d) mailto:// which refers to an e-mail server; (e) wais:// which refers to a Wide Area Information server; (f) gopher:// which refers to a Gopher server; (g) file:// which refers to a file stored on a local system; (h) telnet:// which refers to applications stored on a network server; (i) rlogin:// which refers to applications stored on a network server; and, (j) tn3270:// which refers to applications stored on a mainframe. The present invention anticipates that any of these types of URL's may be

encoded on an RFID transponder for retrieval of specific information and applications. It is further anticipated that other types of URL's may be developed in the future to further define the locations of files as the use and scope of computer networks continues to evolve, and that all such URL's can be encoded into the memory of an RFID transponder in the manner described above. The .com portion of the domain name stands for the commercial top level domain category. There are other known top level domain categories, including .org for organization, .edu for educational and .gov for governmental.

Alternatively, the address may comprise an e-mail address used to identify a mailbox for an Internet user, such as a person or business, on the Internet. As known in the art, an e-mail address defines a location on a server that can receive and send e-mail messages. The e-mail messages can thereafter be retrieved by the user using an e-mail client application resident on a computer connected to the server. The format for addressing a message to an Internet user is USERNAME@DOMAIN NAME. For example, the address of the present inventor is Clark.Richter@intermec.com. There are no spaces between any of the words. Clark.Richter is the user name and intermec.com is the domain name (as described above with respect to URL's).

The relationship between the RFID tag 30 and the location defined by the Internet address can take numerous forms. If the address is a URL, the URL may identify the location of a Hypertext Markup Language (HTML) encoded document stored in a hypertext transfer protocol (HTTP) server somewhere on the Internet. The HTML-encoded document may comprise additional information regarding the item to which the RFID tag 30 is affixed. For example, the RFID tag 30 may be affixed to a particular object, such as a container of hazardous materials. By reading the RFID tag 30 with a browser-enabled RFID reader, such as the client computer 16 or scanning terminal 24 described above, the web site associated with the object can be retrieved and the HTML-encoded document associated with the URL displayed on the screen. In this example, the HTML-encoded document may include a detailed description of the

contents of the container, the toxicity and/or radioactivity levels, clean-up requirements, disposal date, and other important information.

Alternatively, the HTML-encoded document may include an embedded Java-Applet that is executed automatically by a browser-enabled and Java-enabled RFID reader, such as the client computer 16 or scanning terminal 24 described above. For example, the RFID tag 30 may be included in a shipping label affixed to a package, and the web site may be uniquely associated with the particular package. At every stage of processing or shipment of the package, an RFID reader as described above interrogates the RFID tag 30. Upon accessing the web site, the embedded Java-Applet is executed by the client computer 16 or the scanning terminal 24, causing the web site to be updated with information regarding the package, e.g., location, arrival time/date, etc. A customer awaiting delivery of the package can also access the web site to thereby obtain current information regarding the status of the shipment.

If the Internet address is an e-mail address, the address may identify a user that has a relationship to the RFID tag 30. For example, the RFID tag 30 may be included in a shipping label affixed to a package, and the embedded e-mail address may correspond to the customer awaiting delivery of the package. At every stage of processing or shipment of the package, an RFID reader as described above interrogates the RFID tag 30. The RFID reader may then automatically communicate an e-mail message to the embedded address containing information regarding the package, e.g., location, arrival time/date, etc. A customer awaiting delivery of the package can retrieve these e-mail messages to thereby obtain current information regarding the status of the shipment.

Referring now to Fig. 3, a flow chart illustrates operation of a client computer 16 or scanning terminal 24 in association with a connected or integrated RFID reader. The flow chart represents software instructions that are executed by the processor of the client computer 16 or scanning terminal 24 (referred to collectively as the processor). At step 102, the processor commands the RFID reader to transmit an interrogation field in order to communicate with an RFID tag 30. This may be responsive to a trigger

command by an operator of a handheld device, or may be automatically generated by a fixed position RFID reader. At step 104, the processor attempts to detect a response from an RFID tag. It should be appreciated that the RFID reader would be in a transmit mode in step 102 and a receive mode in step 104. At step 106, a response signal is analyzed to determine whether it is a valid response from an RFID tag or a random RF noise signal. If the received signal is determined to be not valid, then the processor returns to step 102 and repeats the aforementioned steps.

Alternatively, if the received signal is determined to be valid, then the processor proceeds to step 108, and the processor attempts to recover the data stored in the RFID tag 30. At step 110, the processor reads the embedded address field to recover the Internet address data. Then, at step 112, the processor launches an appropriate application. If the address corresponds to a URL, and if the browser application is not already active on the desktop of the client computer 16 or scanning terminal 24, the processor launches the browser application. It is anticipated that certain devices may utilize a browser as a front-end application and may therefore be always in an active state. The recovered URL is then loaded into the address window of the browser application, causing the browser to generate a HTTP message communicated through the network 12 to the host server 14 to send a request for a web site with the given URL address (step 114). Unless the desired object associated with the URL address is resident on the host server 14, the host server 14 will route the HTTP message onto the Internet 42. The web site with the URL address may then respond by sending a HTTP message back to the browser application. The HTTP message may include an HTML-encoded document in the form of data packets that define graphical information to be displayed by the browser application. The HTML-encoded document is received and displayed by the browser application, thereby enabling the user to view the information corresponding to the RFID tag 30. Once the web site identified by the URL has been accessed, the processor runs the application or Java-applet associated with the web site (step 116). The operator of the client computer 16 or scanning terminal 24 may be prompted to enter information or data, such as identifying information, or the browser

application may operate autonomously without requiring further interaction by the operator. Thereafter, at step 118, the processor returns to step 102 and is ready to read another RFID tag 30.

Alternatively, if the address corresponds to an e-mail address, and if the e-mail client is not already active on the desktop of the client computer 16 or scanning terminal 24, the processor launches the e-mail client (step 112). The e-mail client then formats an e-mail message containing data recovered from the RFID tag 30, or other data such as date, time, location, temperature, etc. The recovered e-mail address is then loaded into the address field of the e-mail message and the message is sent through the network 12 to the host server 14 (step 114). Unless the user associated with the e-mail address has a mailbox resident on the host server 14, the host server 14 will route the e-mail message onto the Internet 42 to the server hosting the domain name identified in the e-mail address. The operator of the client computer 16 or scanning terminal 24 may be prompted to enter information or data, such as identifying information, or the e-mail client may operate autonomously without requiring further interaction by the operator. Thereafter, at step 118, the processor returns to step 102 and is ready to read another RFID tag 30.

Having thus described a preferred embodiment of an RFID tag having an embedded uniform resource locator, it should be apparent to those skilled in the art that certain advantages of the aforementioned invention have been achieved. It should also be appreciated that various modifications, adaptations, and alternative embodiments thereof may be made within the scope and spirit of the present invention. The invention is further defined by the following claims.